DESCRIPTION

LIQUID-CRYSTAL DISPLAY APPARATUS

Technical Field

The present invention relates to a liquid-crystal display apparatus. More particularly, the present invention relates to electrode structures in each substrate of a liquid-crystal panel which is a constituent of a liquid-crystal display apparatus.

Background Art

Fig. 11 is an exploded perspective view of a conventional liquid-crystal panel. Fig. 12 is a plan view showing an enlargement of an electrode pattern and a terminal, which are formed on a first substrate 10X of the liquid-crystal panel shown in Fig. 11. Fig. 12 is a plan view showing an enlargement of an electrode pattern and a terminal, which are formed on a second substrate 20Y of the liquid-crystal panel shown in Fig. 11. Fig. 14 is a plan view showing an enlargement of an electrode pattern and a terminal when the first substrate 10X shown in Fig. 12 and the second substrate 20Y shown in Fig. 13 are laminated together.

Fig. 11 shows a passive-matrix-type liquid-crystal

display apparatus, in which the first substrate 10X having formed thereon a first electrode pattern 40X, and the second substrate 20Y having formed thereon a second electrode pattern 50Y are laminated together for driving a liquid crystal sandwiched between the first and second electrode patterns. In such a passive-matrix-type liquid-crystal display apparatus, as schematically shown in Fig. 11 in exploded view, a liquid-crystal sealing area 35 is defined by a sealing material 30 between a pair of substrates which are laminated together by the sealing material 30 with a predetermined gap therebetween, and a liquid crystal is sealed inside this liquid-crystal sealing area 35.

In a liquid-crystal panel 1 having such a construction, the second electrode pattern 50Y and a terminal 82X for input from the outside are electrically connected to each other by placing a conductive material between a first terminal 60X for conduction between substrates and a second terminal 70X for conduction between substrates. As a result, it is possible to apply a signal for driving the liquid crystal from the terminal 82X for input from the outside, formed on the first substrate, to the second electrode pattern 50Y formed on the second substrate 20Y. In such a liquid-crystal panel 1, it is possible to input a signal for driving the liquid crystal to the first electrode pattern 40X and the second electrode pattern 50Y, which are formed

on mutually different substrates, from the terminals 81X and 82X for input from the outside, both of which are formed on the first substrate.

In the liquid-crystal panel shown in Fig. 11, the terminals 81X and 82X for input from the outside are formed in a first terminal formation area in proximity to a substrate edge 101X of the first substrate. The conduction between the first terminal 60X for conduction between substrates and a second terminal 70Y for conduction between substrates is made in the first terminal formation area and a second terminal formation ~~region~~area 21Y in proximity to a substrate edge 201X of the second substrate. Here, since the substrate edges 101X and 201~~X~~Y are edges extending in the same direction, in order that the terminals 81X and 82X for input from the outside be connected to an external circuit, such as a driver for driving a liquid crystal, via a flexible substrate (not shown) or a rubber connector, or directly, one end of a first terminal formation area 11X is formed in a portion which does not overlap the substrate 20Y, that is, in a protruding portion 15X protruding from a substrate edge 201Y of the second substrate 20Y. Then, the terminals 81X and 82X for input from the outside, formed therein, are connected, in a portion near the substrate edge 101X, to an external circuit, such as a driver for driving a liquid crystal, via a flexible substrate (not shown) or a

rubber connector, or directly. On the other hand, in order that the first terminal 60X for conduction between substrates and the second terminal 70Y for conduction between substrates are made to electrically conduct with each other, the other end of the first terminal formation area 11X is extended to an area where it overlaps in plan view with a second terminal formation area 21Y of the second substrate 20Y.

Figs. 12 and 13 are plan views showing enlargements of parts of each terminal formation area which are respectively formed on the first substrate 10X and the second substrate 20Y which are used in the conventional liquid-crystal panel 1.

In Figs. 11 and 12, the first terminal formation area 11X formed along the substrate edge 101X of the first substrate 10X is formed with a plurality of first terminals 81X for input from the outside arrayed in the central area of the substrate edge 101X. Also, in an area corresponding to both sides (both ends) where the first terminals 81X for input from the outside is formed, a plurality of second terminals 82X for input from the outside, arrayed along the substrate edge 101X, are formed. Then, from the first terminals 81X for input from the outside, plural rows of first electrode patterns 40X for driving a liquid crystal are formed, and from the second terminal 82X for input from

the outside, the first terminal 60X for conduction between substrates extends to a position at which it overlaps the second terminal formation area 21Y of the second substrate 20Y. The first electrode pattern 40X, the first terminals 81X for input from the outside, the terminal 82X for input from the outside, and the first terminal 60X for conduction between substrates are all formed from an ITO film (Indium Tin Oxide/transparent conductive film), etc.

On the other hand, on the second substrate 20Y, as can be seen from Figs. 11 and 13, at a position corresponding to the first terminal 60X for conduction between substrates of the first substrate 10X within the second terminal formation area 21Y, plural second terminals 70Y for conduction between substrates are formed along the substrate edge 201Y. From these second terminals 70Y for conduction between substrates, there are formed plural rows of second electrode pattern 50Y for driving a liquid crystal, extending in such a manner as to go around an area corresponding to both sides of the area where the first electrode pattern 40X is formed and to intersect the first electrode pattern 40X within the liquid-crystal sealing area 35. The second electrode pattern 50Y and the second terminal 70Y for conduction between substrates are also formed from an ITO film, etc.

In the manner as described above, in the second substrate 20Y, the second electrode pattern 50Y must be

extended from the second terminal 70Y for conduction between substrates in such a manner as to avoid the formation area of the first electrode pattern 40X formed on the first substrate 10X and to go around an area corresponding to both sides of the first electrode pattern 40X. For this reason, the second terminal 70Y for conduction between substrates is formed linearly in an area (in the central area of the substrate edge 201Y) near the end portion of the formation area of the first electrode pattern 40X formed on the first substrate 10X; however, the farther therefrom toward either side, the larger the ratio at which the obliquely extending portion (oblique portion 702Y) occupies. However, the second terminal 70Y for conduction between substrates is, unlike the normal wiring portion, for making a conducti~~ng~~ve connection, by a conductive material sandwiched between the substrates, with the first terminal 60X for conduction between substrates, and therefore, a short-circuit is likely to occur between adjacent terminals. Therefore, to reliably prevent such a short-circuit between adjacent terminals, a sufficiently large spacing must be ensured between adjacent terminals. For this reason, in the second terminal 70Y for conduction between substrates formed in an area (on both sides of the substrate edge 201Y) away from the end portion of the formation area of the first electrode pattern 40X, the lengths of linear portions 701~~y~~Y are varied greatly

between adjacent terminals, and these are obliquely bent therefrom toward the side edges 103X of the substrate 10X in order to form wiring, so that the spacing between the oblique portions 702Y of the second terminal 70Y for conduction between substrates is secured to be wide. Therefore, as can be seen from Fig. 13, an angle α between the line E connecting the boundary between the linear portions 701Y and the oblique portions 702Y and the substrate edge 201Y in the second terminal 70Y for conduction between substrates is very large.

In contrast, in a portion where the second terminal 70Y for conduction between substrates extends straight to an area near the formation area of the first electrode pattern 40X, even if the second electrode pattern 50Y extending therefrom is oblique, conduction between substrates by a conductive material is not performed in this oblique portion 502Y, making it possible to significantly decrease the spacing between adjacent patterns. Therefore, the angle formed by the line connecting the boundary between the linear portions 501Y and the oblique portions 502Y with the substrate edge 201Y in the second electrode pattern 50Y is very small.

In constructing the liquid-crystal panel 1 by using the first substrate 10X and the second substrate 20Y formed in this manner, as shown in Figs. 11 and 14, when the first

substrate 10X and the second substrate 20Y are laminated together via the sealing material 30, a gap material and a conductive material are mixed in advance in the sealing material 30, and the sealing material 30 is also formed by coating or by printing in an area where the first terminal 60X for conduction between substrates and the second terminal 70Y for conduction between substrates overlap. Therefore, when the first substrate 10X and the second substrate 20Y are laminated together via the sealing material 30Y, the first terminal 60X for conduction between substrates comes into electrical conduction with the second terminal 70Y for conduction between substrates by the conductive material contained in the sealing material 30. Also, when the first substrate 10X and the second substrate 20Y are laminated together, pixels 5 are formed in a matrix by the intersecting portions of the first electrode pattern 40X and the second electrode pattern 50Y. As a result, after a flexible substrate is mounted by using an anisotropic conductive material, etc., at a position near the substrate edge 101X of the first terminal formation area 11X of the first substrate 10X, when a signal is input to the first terminals 81X for input from the outside and the second terminal 82X for input from the outside of the first substrate 10X via this flexible substrate, image data can be applied to the first electrode pattern 40X formed on the

first substrate 10X via the first terminals 81X for input from the outside, and a scanning signal can be applied to the second electrode pattern 50Y formed on the second substrate 20Y via the first terminal 82X for input from the outside, the first terminal 60X for conduction between substrates, the conductive material, and the second terminal 70Y for conduction between substrates.

However, in the above-described conventional technology, conduction is performed by using an obliquely extending second terminal 70Y for conduction between substrates. For this reason, if attempts are made to obtain a terminal width of inter-substrate conduction terminals or the width between adjacent terminals which is sufficient to ensure the reliability of inter-substrate conduction, a substantial spacing must be provided in the oblique portions 702Y by greatly varying the lengths of the linear portions 701~~y~~Y between adjacent terminals. That is, there is the problem of failing to utilize the area outside the display area. For this reason, in the conventional electrode structure, there is a problem in that the number of second electrode patterns 50Y and the number of second terminals 70Y for conduction between substrates, formed between (the area width indicated by the arrow B) the corner portion where the pattern positioned at the outermost part of the first electrode pattern 40X formed on the first substrate 10X is

bent near the display area and the base-end portion of the terminal positioned at the outermost part in the second terminal formation area 21Y cannot be substantially increased. If the number of second electrode patterns 50Y and the number of second terminals 70Y for conduction between substrates were increased, as shown in Fig. 14, there is a problem in that, in an area 250, the second electrode pattern 50Y overlaps the first electrode pattern 40X, increasing the probability of the occurrence of a short-circuit between substrates. Also, if the spacing of the oblique portions 702Y of the second terminal 70Y for conduction between substrates is decreased to secure an area in which the second electrode pattern 50Y is added for the purpose of increasing the number of second electrode patterns 50Y and the number of second terminals 70Y for conduction between substrates, this increases the probability that a short-circuit will occur between substrates. Furthermore, when an area where the second electrode pattern 50Y is added is secured by decreasing the area width indicated by the arrow B, for example, by decreasing the line width and spacing of the second electrode patterns 50Y and the second terminals 70Y for conduction between substrates, electrical resistance (wiring resistance) is increased, and display quality is decreased.

Accordingly, an object of the present invention is to

provide a liquid-crystal panel of a type in which a signal is input from a terminal for input from the outside, formed on one substrate of a pair of substrates which hold a liquid crystal, and a signal is input to the other substrate by performing conduction between substrates by using a conductive material sandwiched between the substrates, so that the number of electrode patterns for driving a liquid crystal can be increased without decreasing reliability and display quality by effectively using the wiring area of a non-display area.

Disclosure of the Invention

In order to solve the above-described problems, the present invention comprises: a first substrate having a first terminal for conduction between substrates, located adjacent to the edge of the substrate, and having a first electrode pattern which is electrically connected to the first ~~substrate~~terminal for conduction between substrates and which is arranged so as to extend toward an edge opposing the edge to which the first ~~substrate~~terminal for conduction between substrates is adjacent; and a second substrate having a first terminal for input from the outside located adjacent to the edge of the substrate, a second terminal for conduction between substrates, which is electrically connected to the first ~~substrate~~terminal for

input from the outside, second terminals for input from the outside, located on both sides of the first terminal for input from the outside, and a second electrode pattern which is electrically connected to the second terminal for input from the outside, characterized in that the first substrate and the second substrate are located in an opposed manner so as to extend in a direction in which the first electrode pattern and the second electrode pattern intersect with each other, and the first terminal for conduction between substrates and the second terminal for conduction between substrates are electrically connected to each other by a conductive material sandwiched between the first substrate and the second substrate.

In a first liquid-crystal display apparatus of the present invention, by forming a connection via a conductive material between the first terminal for conduction between substrates, formed on the first substrate, to the second terminal for conduction between substrates, formed on the second substrate, what is commonly called "conduction between substrates" is performed, in which the first electrode pattern on the first substrate and the first terminal for input from the outside on the second substrate are electrically connected to each other. In the present invention, when performing this conduction between substrates, the first electrode pattern formed so as to

extend toward the edge opposing the edge in which the first terminal for conduction between substrates is formed is connected to the first terminal for input from the outside, formed on the second substrate. Also, the second electrode pattern formed so as to extend in a direction intersecting the first electrode pattern is connected to the second terminals for input from the outside, located on ~~either~~both sides of the first terminal for input from the outside without making conduction between substrates. According to this construction, since the first electrode pattern is used for conduction between substrates, the number of second electrode patterns can be increased without concern for the reliability of conduction between substrates. This is because, even if the number of patterns of a portion (for example, A in Fig. 4), where the pattern must be extended obliquely, is increased, since this pattern is not a pattern used for conduction between substrates, it does not matter even if the width between adjacent patterns is decreased. Therefore, even if the number of second electrode patterns is increased, it is not necessary to decrease the spacing between the terminals for conduction between substrates, and it is not necessary to decrease the line width of the first pattern. Therefore, according to the present invention, the number of electrode patterns for driving a liquid crystal can be increased without decreasing reliability and display

quality. Also, even when the number of second electrode patterns is not increased very much, since a portion where the pattern must be extended obliquely can be narrowed, it is possible to expand the display area in a liquid-crystal panel having outer dimensions equal to the conventional ones.

Furthermore, in the present invention, preferably, the first terminal for conduction between substrates and the second terminal for conduction between substrates are located linearly toward an edge opposing the edge to which the terminals are adjacent. That is, in an area where the first terminal for conduction between substrates and the second terminal for conduction between substrates perform conduction between substrates, by forming the pattern into one which is not formed obliquely, the distance between terminals can be sufficiently secured, thereby improving the reliability of conduction between substrates.

Furthermore, in the present invention, preferably, image data is supplied to the first electrode pattern, and a scanning signal is supplied to the second electrode pattern. In the liquid-crystal device having such a construction, the first electrode pattern is used as a data electrode pattern by which image data is supplied, for example, via the first terminal for input from the outside, the second terminal for conduction between substrates, the conductive material, and the first terminal for conduction between substrates. The

second electrode pattern is used as a scanning electrode pattern by which a scanning signal is applied via the second terminal for input from the outside.

A second liquid-crystal display apparatus of the present invention comprises: a first substrate having a first terminal for conduction between substrates, located adjacent to the edge of the substrate, and having a first electrode pattern which is electrically connected to the first ~~substrate~~terminal for conduction between substrates and which is arranged so as to extend toward an edge opposing the edge to which the first ~~substrate~~terminal for conduction between substrates is adjacent; and a second substrate having an input terminal for input from the outside, located adjacent to the edge of the substrate, a second terminal for conduction between substrates, and a second electrode pattern, the substrates located in an opposed manner so as to extend in a direction in which the first electrode pattern and the second electrode pattern intersect with each other, characterized by having a driving IC, mounted on the second substrate, an input terminal being electrically connected to the terminal for input from the outside, and an output terminal being electrically connected to the second terminal for conduction between substrates and the second electrode pattern, and characterized in that the first terminal for conduction between substrates and the

second terminal for conduction between substrates are electrically connected to each other by a conductive material sandwiched between the first substrate and the second substrate.

In the second liquid-crystal display apparatus of the present invention, what is commonly called "conduction between substrates" is performed, in which the first terminal for conduction between substrates, formed on the first substrate, and the second terminal for conduction between substrates, formed on the second substrate, are connected to each other by a conductive material. For this reason, the first electrode pattern on the first substrate is connected to the output terminal of a driving IC, mounted onto the second substrate, via the first and second terminals for conduction between substrates. In the present invention, when performing this conduction between substrates, the first electrode pattern is used, which is formed so as to extend toward the edge opposing the edge in which the first terminal for conduction between substrates is formed. Also, the second electrode pattern arranged so as to extend in a direction intersecting the first electrode pattern is connected to the output terminal of the driving IC without making conduction between substrates. According to this construction, since the first electrode pattern is used for conduction between substrates, the number of second

electrode patterns can be increased without concern for the reliability of conduction between substrates. The reason for this is that even if the number of patterns of a portion (for example, A in Fig. 4) where the pattern must be extended obliquely is increased, since this pattern is not a pattern used for conduction between substrates, it does not matter even if the width between adjacent patterns is decreased. Therefore, even if the number of second electrode patterns is increased, it is not necessary to decrease the spacing between the terminals for conduction between substrates, and it is not necessary to decrease the line width of the first pattern. Therefore, according to the present invention, the number of electrode patterns for driving a liquid crystal can be increased without decreasing reliability and display quality.

Furthermore, in the second liquid-crystal display apparatus of the present invention, various types of constructions for use with the above-described first liquid-crystal display apparatus can be employed; for example, the following can be employed:

(1) The first terminal for conduction between substrates and the second terminal for conduction between substrates are formed linearly toward the edge opposing the edge in which the terminals are formed.

(2) Image data is supplied to the first electrode

pattern, and a scanning signal is supplied to the second electrode pattern.

The operation and effects by the above-described (1) and (2) are comparable to those of the above-described first liquid-crystal display apparatus of the present invention, and accordingly, descriptions thereof are omitted here.

Brief Description of the Drawings

Fig. 1 is a perspective view showing the exterior of a liquid-crystal panel used in a liquid-crystal display apparatus according to a first embodiment of the present invention.

Fig. 2 is a perspective view schematically showing the state in which the liquid-crystal panel shown in Fig. 1 is exploded.

Fig. 3 is a plan view showing an enlargement of an electrode pattern and a terminal, which are formed on a first substrate of the liquid-crystal panel shown in Fig. 2.

Fig. 4 is a plan view showing an enlargement of an electrode pattern and a terminal, which are formed on a second substrate of the liquid-crystal panel shown in Fig. 2.

Fig. 5 is a plan view showing an enlargement of an electrode pattern and a terminal when the first substrate shown in Fig. 3 and the second substrate shown in Fig. 4 are laminated together.

Fig. 6 is a perspective view showing the exterior of a liquid-crystal panel used in a liquid-crystal display apparatus according to a second embodiment of the present invention.

Fig. 7 is a perspective view schematically showing a state in which the liquid-crystal panel shown in Fig. 6 is exploded.

Fig. 8 is a plan view showing an enlargement of an electrode pattern and a terminal, which are formed on a first substrate of the liquid-crystal panel shown in Fig. 7.

Fig. 9 is a plan view showing an enlargement of an electrode pattern and a terminal, which are formed on a second substrate of the liquid-crystal panel shown in Fig. 7.

Fig. 10 is a plan view showing an enlargement of an electrode pattern and a terminal when the first substrate shown in Fig. 8 and the second substrate shown in Fig. 9 are laminated together.

Fig. 11 is an exploded perspective view of a conventional liquid-crystal panel.

Fig. 12 is a plan view showing an enlargement of an electrode pattern and a terminal, which are formed on a first substrate of the liquid-crystal panel shown in Fig. 11.

Fig. 1~~2~~3 is a plan view showing an enlargement of an electrode pattern and a terminal, which are formed on a second substrate of the liquid-crystal panel shown in Fig.

11.

Fig. 14 is a plan view showing an enlargement of an electrode pattern and a terminal when the first substrate shown in Fig. 12 and the second substrate shown in Fig. 13 are laminated together.

Best Mode for Carrying out the Invention

Embodiments of the present invention are described with reference to the accompanying drawings.

[First Embodiment]

(Overall construction)

Fig. 1 is a perspective view showing the exterior of a liquid-crystal panel used in a liquid-crystal display apparatus according to this embodiment. Fig. 2 is a perspective view schematically showing a state in which this liquid-crystal panel is exploded. Fig. 3 is a plan view showing an enlargement of an electrode pattern and a terminal, which are formed on a first substrate of the liquid-crystal panel shown in Fig. 2. Fig. 4 is a plan view showing an enlargement of an electrode pattern and a terminal, which are formed on a second substrate of the liquid-crystal panel shown in Fig. 2. Since in Figs. 1 and 2, an electrode pattern, a terminal, etc., are merely shown schematically, details thereof will be described later with

reference to Figs. 3 and 4 showing enlargements of parts of an electrode pattern and a terminal.

In Figs. 1 and 2, a liquid-crystal panel 1 used in a passive-matrix-type liquid-crystal display apparatus mounted in an electronic ~~apparatus~~equipment, such as a portable telephone, is formed so that a first substrate 10 and a second substrate 20, formed of glass, plastic, etc., are laminated together with a predetermined gap therebetween in an opposed manner via a sealing material 30. A liquid crystal is sealed within a liquid-crystal sealing area 35 defined by the sealing material 30. The first substrate 10 is formed with plural rows of first electrode patterns 40 extending in the vertical direction within the liquid-crystal sealing area 35, and the second substrate 20 is formed with plural rows of second electrode patterns 50 extending in the horizontal direction within the liquid-crystal sealing area 35.

In the liquid-crystal panel 1 shown herein, a polarizer~~polarizing plate~~ 5 is laminated on the outer surface of the second substrate 20 by an adhesive, etc., and a polarizer~~polarizing plate~~ 6 is also laminated on the outer surface of the first substrate 10 by an adhesive, etc. When the liquid-crystal panel 1 is formed to be of the reflective type, a reflecting plate (not shown) is laminated on the outer side of the polarizer~~polarizing plate~~s 5 and 6, or a

reflecting plate is laminated in place of the polarizer~~polarizing plate~~s 5 and 6.

In the liquid-crystal panel 1 constructed as described above, first and second terminals 81 and 82 for input from the outside are formed in the second terminal formation area in proximity to a substrate edge 201 of the second substrate. Then, the conduction between a first terminal 60 for conduction between substrates and a second terminal 70 for conduction between substrates is made in a first terminal formation area 11 and a second terminal formation area 21 in proximity to a substrate edge 101 of the first substrate. Here, since the first substrate edges 101 and 102 are edges extending in the same direction, in order that the first and second terminals 81 and 82 for input from the outside be connected to an external circuit, such as a driver for driving a liquid crystal, via a flexible substrate (not shown) or a rubber connector, or directly, one end of the second terminal formation area 21 is formed in a portion which does not overlap the substrate ~~2~~10, that is, in a protruding portion protruding from the substrate edge 101 of the first substrate 10. For this reason, as the second substrate 20, a substrate larger than the first substrate 10 is used. On the other hand, in order that the first terminal 60 for conduction between substrates and the second terminal 70 for conduction between substrates be

electrically conductive with each other, the other end of the second terminal formation area 21 is extended up to an area where it overlaps in plan view with the first terminal formation area 11 of the first substrate 10.

In this embodiment, as shown in Figs. 2 and 3, the first terminal formation area 11 is formed along the central portion of the substrate edge 101 of the first substrate 10, and in this first terminal formation area 11, a plurality of first terminals 60 for conduction between substrates are arrayed with a predetermined spacing along the substrate edge 101. Also, on the first substrate 10, plural rows of first electrode patterns 40 for driving a liquid crystal extend obliquely, spreading toward both sides, from the first terminal 60 for conduction between substrates toward the substrate edge 102, after which the first electrode patterns 40 extend in a direction intersecting the substrate edges 101 and 102 at right angles within the liquid-crystal sealing area 35. Here, the first electrode pattern 40 and the first terminal 60 for conduction between substrates are formed from an ITO film formed in a predetermined pattern.

As shown in Figs. 2 and 4, on the second substrate 20, the second terminal formation area 21 is also formed along a substrate edge 201, and this second terminal formation area 21 is formed over a relatively broad area, excluding both ends of the substrate edge 201. The second terminal

formation area 21 is formed with plural first terminals 81 for input from the outside arrayed with a predetermined spacing along the substrate edge 201 in the central area of the second terminal formation area 21, and plural second terminals 82 for input from the outside arrayed with a predetermined spacing along the substrate edge 201 in the two places on both sides of the area where these first terminals 81 for input from the outside are formed. Here, the first terminals 81 for input from the outside and the second terminals 82 for input from the outside are all extended toward an opposing substrate edge 202 (see Fig. 2) in the second terminal formation area 21.

Also, on the second substrate 20, from the first terminals 81 for input from the outside, plural second terminals 70 for conduction between substrates which overlap the first terminal 60 for conduction between substrates when the first substrate 10 and the second substrate 20 are laminated together extend linearly toward the substrate edge 202.

Furthermore, on the second substrate 20, from the second terminal 82 for input from the outside, plural rows of second electrode patterns 50 for driving a liquid crystal are formed to go around an area corresponding to both sides of the formation area of the first electrode pattern 40 when the first substrate 10 and the second substrate 20 are

laminated together. Then, these second electrode patterns 50 extend so as to intersect the first electrode pattern 40 within the liquid-crystal sealing area 35. That is, the wiring of the second electrode patterns 50 formed on the second substrate 20, in each area corresponding in plan view to both sides of the area where the first electrode pattern 40 on the first substrate 10 is formed when the first substrate 10 and the second substrate 20 are laminated together, extend obliquely toward a side edge 203 in each of the sides, after which the wiring extends linearly toward the opposing substrate edge 202 along the liquid-crystal sealing area 35 (or the side edge 203 of the substrate 20), and after an appropriate place, the wiring extends in parallel with the substrate edges 201 and 202 within the liquid-crystal sealing area 35. Here, the second electrode pattern 50, the first terminals 81 for input from the outside, the second terminal 82 for input from the outside, and the second terminal 70 for conduction between substrates are all formed from an ITO film formed in a predetermined pattern.

In constructing the liquid-crystal panel 1 by using the first substrate 10 and the second substrate 20 formed in this manner, in this embodiment, when the first substrate 10 and the second substrate 20 are laminated together via the sealing material 30, a gap material and a conductive

material are mixed in advance in the sealing material 30, and the sealing material 30 is also formed in an area where the first terminal 60 for conduction between substrates and the second terminal 70 for conduction between substrates overlap each other. Here, the conductive material contained in the sealing material 304 is metallic particles or particles for plating to be performed on the surfaces of elastically deformable plastic beads. In the case of particles for plating to be performed on the surfaces of elastically deformable plastic beads, the particle diameter thereof is approximately 6.6 μm. In contrast, the particle diameter of the gap material contained in the sealing material 304 is approximately 5.6 μm. Therefore, when the sealing material 30 is melted and cured while applying a pressing force such as that which decreases a gap between the first substrate 10 and the second substrate 20 in a state in which these substrates are stacked one on the other, the conductive material causes the first terminal 60 for conduction between substrates to be electrically conductive with the second terminal 70 for conduction between substrates in a state in which the conductive material is crushed between the first substrate 10 and the second substrate 20.

Fig. 5 is a plan view showing an enlargement of an electrode pattern and a terminal when the first substrate

shown in Fig. 3 and the second substrate shown in Fig. 4 are laminated together.

As shown in Fig. 5, when the first substrate 10 and the second substrate 20 are laminated together via the sealing material 30, pixels 5 are formed in a matrix by the intersecting portions of the first electrode patterns 40 and the second electrode patterns 50. As a result, after a flexible substrate 90 is mounted in the end portion adjacent to the substrate edge 201 of the second terminal formation area 21 of the second substrate 20 by using an anisotropic conductive material, etc., when a signal is input to the first terminals 81 for input from the outside and the second terminal 82 for input from the outside of the second substrate 20 via an external circuit, etc., such as this flexible substrate 90, a scanning signal can be applied to the second electrode pattern 50 formed on the second substrate 20 via the second terminal 82 for input from the outside, and image data signals can be input to the first electrode pattern 40 formed on the first substrate 10 via the first terminals 81 for input from the outside, the second terminals 70 for conduction between substrates, the conductive material, and the first terminal 60 for conduction between substrates. Therefore, since the image data and the scanning signal allow the orientation state of the liquid crystal positioned between the first electrode

patterns 40 and the second electrode patterns 50 in each pixel 5 to be controlled, a predetermined image can be displayed.

Conventionally, for the first electrode patterns 40 in the vertical direction, a signal is input directly from a terminal for input from the outside without vertical conduction between substrates, and for the second electrode pattern 50 in the horizontal direction which is extended around to both sides so as to avoid this first electrode pattern 40, a signal is input via a terminal extending obliquely for conduction between substrates. In this embodiment, in contrast, a signal is input directly to the second electrode pattern 50 in the horizontal direction which is extended to both sides so as to avoid the first electrode pattern 40, from the second terminal 82 for input from the outside without vertical conduction between substrates. On the other hand, a signal is input to the first electrode pattern 40 in the vertical direction via conduction between substrates from the first terminals 81 for input from the outside. For this reason, it is not necessary to obliquely form the terminal for conduction between substrates, and therefore, the first terminal 60 for conduction between substrates and the second terminal 70 for conduction between substrates can be formed linearly. That is, since there is no need to perform conduction between

substrates in a portion (an area (area width indicated by arrow A) where the pattern must be formed obliquely between the corner portion where the pattern positioned at the innermost part of the second electrode patterns 50 is bent near the display area and the corner portion where the pattern positioned at the outermost part of the second electrode patterns 50 is bent near the display area) where the pattern must be extended obliquely, stable connection is ensured, and connection reliability is improved. Also, in the portion where the pattern must be extended obliquely, the distance (pitch distance) between patterns can be decreased, and the second electrode pattern 50, formed so as to have a narrow pitch, is formed. For this reason, in the second electrode pattern 50, the length of a linear portion 501 need only be varied slightly between adjacent patterns and be bent obliquely therefrom, allowing the spacing between oblique portions 502 of the second electrode pattern 50 to be decreased. Therefore, as can be seen from Fig. 4, even in such an area, in which there is a severe limitation on the layout, a large number of patterns can be formed by an amount corresponding to the angle β formed by the line F connecting the boundary between the linear portion 501 and the oblique portion 502 in the second electrode pattern 50 with the substrate edge 201 being small. Therefore, even when the number of patterns formed in such an area, in which

there is a severe limitation on the layout, is to be increased, it is not necessary to decrease the spacing between the first terminal 60 for conduction between substrates and the second terminal 70 for conduction between substrates, and it is not necessary to decrease the line width of the patterns. Therefore, according to this embodiment, it is possible to increase the number of electrode patterns for driving a liquid crystal without decreasing reliability and display quality. Furthermore, in the liquid-crystal panel in which vertical conduction between substrates is required, since the portion where the pattern must be extended obliquely on the second substrate 20 can be narrowed more than in the conventional case if the number of patterns is equal, the outer shape can be formed to be smaller. In the liquid-crystal panel 1 of a size having the same outer dimensions, a larger expanded display area can be provided. Furthermore, if the portion where the pattern must be extended obliquely can be narrowed more than in the conventional case on the second substrate 20, the outer dimensions of the liquid-crystal panel 1 can be decreased in the liquid-crystal panel 1 of a size having a display area equal to that of a conventional one.

[Second Embodiment]

On the liquid-crystal panel 1, there are cases in which

a driving IC is COG (Chip on Glass)-mounted or COP (Chip on Plastic Panel)-mounted on a substrate. In this case, a signal is input to the driving IC from the outside, and an image data signal and a scanning signal are output to each electrode pattern from the driving IC. Cases in which the present invention is applied to a liquid-crystal panel of such a type are described with reference to Figs. 6, 7, 8, 9, and 10.

Fig. 6 is a perspective view showing the exterior of a liquid-crystal panel used in a liquid-crystal display apparatus according to this embodiment. Fig. 7 is a perspective view schematically shows a state in which this liquid-crystal panel is exploded. Fig. 8 is a plan view showing an enlargement of an electrode pattern and a terminal, which are formed on a first substrate of the liquid-crystal panel shown in Fig. 7. Fig. 9 is a plan view showing an enlargement of an electrode pattern and a terminal, which are formed on a second substrate of the liquid-crystal panel shown in Fig. 7. Since in Figs. 6 and 7, an electrode pattern, a terminal, etc., are merely shown schematically, details thereof will be described later with reference to Figs. 8 and 9 showing enlargements of parts of an electrode pattern and a terminal.

In Figs. 6 and 7, the liquid-crystal panel 1 of this embodiment is formed so that a first substrate 10 and a

second substrate 20, formed from glass, plastic, etc., are laminated together with a predetermined gap therebetween in an opposed manner via a sealing material 30. A liquid crystal is sealed within a liquid-crystal sealing area 35 defined by the sealing material 30. The first substrate 10 is formed with plural rows of first electrode patterns 40 extending in the vertical direction within the liquid-crystal sealing area 35, and the second substrate 20 is formed with plural rows of second electrode patterns 50 extending in the horizontal direction within the liquid-crystal sealing area 35. In the liquid-crystal panel 1 shown herein, a polarizer~~polarizing plate~~ 5 is laminated on the outer surface of the second substrate 20, and a polarizer~~polarizing plate~~ 6 is also laminated on the outer surface of the first substrate 10. When the liquid-crystal panel 1 is formed to be of the reflective type, a reflecting plate (not shown) is laminated on the outer side of the polarizer~~polarizing plate~~s 5 and 6 or a reflecting plate is laminated in place of the polarizer~~polarizing plate~~s 5 and 6.

In the liquid-crystal panel 1 constructed as described above, when either signal input from the outside or conduction between substrates is performed, a first terminal formation area 11 and a second terminal formation area 21 respectively formed on the first substrate 10 and the second substrate 20 are used. Therefore, as the second substrate

20, a substrate larger than the first substrate 10 is used, and connection of the flexible substrate 90 or a rubber connector (not shown), such as conductive rubber, is performed by using the protruding portion of the second substrate 20 protruding from the substrate edge 101 of the first substrate 10 when the first substrate 10 and the second substrate 20 are stacked by being laminated together.

In constructing such a connection structure, in this embodiment, as shown in Figs. 7 and 8, on the first substrate 10, the first terminal formation area 11 is formed along the central portion of the substrate edge 101 of the first substrate 10, and in this first terminal formation area 11, plural first terminals 60 for conduction between substrates are arrayed with a predetermined spacing along the substrate edge 101. Also, on the first substrate 10, plural rows of first electrode pattern 40 for driving a liquid crystal extend obliquely in such a manner as to spread toward both sides toward the opposing substrate edge 102 from the first terminal 60 for conduction between substrates, after which the first electrode patterns 40 are extended in a direction intersecting the substrate edges 101 and 102 at right angles within the liquid-crystal sealing area 35.

As shown in Figs. 7 and 9, on the second substrate 20, the second terminal formation area 21 is also formed along

the substrate edge 201. This second terminal formation area 21 is formed over a relatively broad area, excluding both ends of the substrate edge 201, and this second terminal formation area is formed with plural terminals 80 for input from the outside arrayed with a predetermined spacing along the substrate edge 201. The terminals 80 for input from the outside extend linearly toward the opposing substrate edge 202 (see Fig. 7) in the second terminal formation area 21. The driving IC 8 for supplying image data to the first electrode patterns 40 and for supplying the second electrode patterns 50 is mounted in a protruding portion 25. The input terminal of the driving IC 8 is connected to a terminal 80 for input from the outside (the connection portion of the terminal 80 for input from the outside and the driving IC is omitted), and a signal from outside the liquid-crystal panel 1 is input from the terminal 80 for input from the outside to the driving IC 8. The output terminals of the driving IC are connected to the first electrode patterns 40 via the second electrode patterns 50, and the first and second first terminals 60 and 70 for conduction between substrates.

In this embodiment, on the second substrate 20, a semiconductor (IC) mounting area 7 is formed in an adjacent area in the liquid-crystal sealing area 35 with respect to the terminal 80 for input from the outside, with the driving

IC 8 being mounted in this semiconductor (IC) mounting area 7. From the output terminals (terminals positioned in the central area of the second terminal formation area 21) of the driving IC 8 located in the longitudinal central area of this semiconductor (IC) mounting area 7, plural second terminals 70 for conduction between substrates are formed so as to be wired linearly toward the substrate edge 202 up to the position which corresponds to and overlaps the first terminal 60 for conduction between substrates when the first substrate 10 and the second substrate 20 are laminated together. (The connection portion of the second terminal 70 for conduction between substrates, a linear portion 501 of the second electrode pattern 50, and a driving IC is omitted). Also, from the output terminal (the terminal positioned in the both side areas of the second terminal formation area 21) of the driving IC located in longitudinal both side areas of the semiconductor (IC) mounting area 7, plural rows of second electrode patterns 50 for driving a liquid crystal are formed via the oblique portion 502 from the linear portion 501 in such a manner as to go around the area corresponding to both sides of the formation area of the first electrode pattern 40 when the first substrate 10 and the second substrate 20 are laminated together, and these second electrode patterns 50 extend so as to intersect the first electrode pattern 40 within the liquid-crystal

sealing area 35.

In constructing the liquid-crystal panel 1 by using the first substrate 10 and the second substrate 20 formed in this manner, in this embodiment, when the first substrate 10 and the second substrate 20 are laminated together via the sealing material 30, a gap material and a conductive material are mixed in advance in the sealing material 30, and the sealing material 30 is also formed in an area where the first terminal 60 for conduction between substrates and the second terminal 70 for conduction between substrates overlap each other. Therefore, when the sealing material 30 is melted and cured while applying a force to narrow a gap between the first substrate 10 and the second substrate 20 in a state in which these substrates are stacked one on the other, the conductive material causes the first terminal 60 for conduction between substrates to electrically conduct with the second terminal 70 for conduction between substrates in a state in which the conductive material is pressed or crushed between the first substrate 10 and the second substrate 20.

Fig. 10 is a plan view showing an enlargement of an electrode pattern and a terminal when the first substrate shown in Fig. 8 and the second substrate shown in Fig. 9 are laminated together.

As shown in Fig. 10, when the first substrate 10 and

the second substrate 20 are laminated together via the sealing material 30, pixels 5 are formed in a matrix by the intersecting portions of the first electrode patterns 40 and the second electrode patterns 50. As a result, after a flexible substrate 90 is mounted in the end portion adjacent to the substrate edge 201 of the second terminal formation area 21 of the second substrate 20 by using an anisotropic conductive material, etc., when a signal is input to the first terminals 80 for input from the outside via this flexible substrate 90, a scanning signal can be applied to the second electrode patterns 50 from the driving IC 8, and image data signals can be input to the first electrode pattern 40 formed on the first substrate 10 from the driving IC 8 via the second terminal 70 for conduction between substrates, the conductive material, and the first terminal 60 for conduction between substrates. Therefore, since the image data and the scanning signal allow the orientation state of the liquid crystal positioned between the first electrode patterns 40 and the second electrode patterns 50 in each pixel 5 to be controlled, a predetermined image can be displayed.

In the manner as described above, conventionally, for the first electrode patterns 40 in the vertical direction, a signal is input directly from the terminal for input from the outside, and for the second electrode pattern 50 in the

horizontal direction, which is extended to both sides so as to avoid this first electrode pattern 40, a signal is input via the terminal extending obliquely for conduction between substrates. In this embodiment, for the second electrode pattern 50 in the horizontal direction, which is extended to both sides so as to avoid this first electrode pattern 40, a signal is input directly from the driving IC 8, so that when a signal is input by conduction between substrates, the first terminal 60 for conduction between substrates and the second terminal 70 for conduction between substrates, which perform conduction between substrates, can be formed linearly.

In the manner as described above, for the first electrode patterns 40 in the vertical direction, a signal is input by conduction between substrates via the second substrate 2. Therefore, there is no need to perform conduction between substrates in an area (area where the pattern must be formed obliquely between the corner portion where the pattern positioned at the innermost part of the second electrode patterns 50 is bent near the display area and the corner portion of the pattern positioned at the outermost part of the second electrode patterns 50 (area width indicated by arrow A)) where the pattern must be formed obliquely, and in that portion, only the second electrode pattern 50 can be formed to decrease the distance

between patterns. For this reason, in the second electrode patterns 50, the length of a linear portion 501 need only be varied slightly between the adjacent patterns and be bent obliquely therefrom, allowing the spacing between oblique portions 502 of the second electrode pattern 50 to be decreased. Therefore, as can be seen from Fig. 9, even in such an area, in which there is a severe limitation on the layout, a large number of patterns can be formed by an amount corresponding to the angle β formed by the line F connecting the boundary between the linear portion 501 and the oblique portion 502 in the second electrode pattern 50 with the substrate edge 201 being small. Therefore, even when the number of patterns formed in such an area, in which there is a severe limitation on the layout, is to be increased, it is not necessary to decrease the spacing between the first terminal 60 for conduction between substrates and the second terminal 70 for conduction between substrates. Furthermore, it is not necessary to decrease the line width of patterns. Therefore, according to this embodiment, the number of electrode patterns for driving a liquid crystal can be increased without decreasing reliability and display quality. In other words, if the number of patterns is equal, since the portion where the pattern must be extended obliquely on the second substrate 20 can be narrowed more than that in a conventional one, in

a liquid-crystal panel 1 having a size in which the outer dimensions are equal, the display area can be expanded. Furthermore, if the portion where the pattern must be extended obliquely on the second substrate 20 can be narrowed more than that in a conventional one, in the liquid-crystal panel 1 having a size in which the display area is equal to that in a conventional one, the outer dimensions thereof can be decreased.

[Other Embodiments]

In the first embodiment, both the first electrode pattern 40 and the second electrode pattern 50 are constructed in such a way that image data or a scanning signal is supplied from an external driving IC, which is provided outside the liquid-crystal panel, via the terminals 81 and 82 for input from the outside. In the second embodiment, both the first electrode pattern 40 and the second electrode pattern 50 are constructed in such a way that image data and a scanning signal are supplied from the driving IC 8 mounted on the second substrate. In the case of a construction in which, for the first electrode pattern, a signal is input by using conduction between substrates, the first embodiment and the second embodiment may be combined. That is, the construction may also be formed in such a way that image data is applied to the first electrode

pattern 40 by using conduction between substrates from the driving IC, mounted on a glass substrate or a plastic substrate, and a scanning signal is applied to the other second electrode pattern 50 from an external driving IC outside the liquid-crystal panel.

Although the flexible substrate 90 is connected to the terminals 80, 81, and 82 for input from the outside, other circuit substrates may be connected thereto via a rubber connector, etc.

CLAIMS

1. A liquid-crystal display apparatus comprising:

a first substrate having a first terminal for conduction between substrates, located adjacent to the edge of the substrate, and having a first electrode pattern which is electrically connected to said first substrate for conduction between substrates and which is arranged so as to extend toward an edge opposing the edge to which said first substrate for conduction between substrates is adjacent; and

a second substrate having a first terminal for input from the outside located adjacent to the edge of the substrate, a second terminal for conduction between substrates, which is electrically connected to said first ~~substrate~~terminal for input from the outside, a second terminal~~s~~ for input from the outside, located on both sides of said first terminal for input from the outside, and a second electrode pattern which is electrically connected to said second terminal for input from the outside,

characterized in that said first substrate and said second substrate are located in an opposed manner so as to extend in a direction in which said first electrode pattern and said second electrode pattern intersect with each other, and

said first terminal for conduction between substrates

and said second terminal for conduction between substrates are electrically connected to each other by a conductive material sandwiched between said first substrate and said second substrate.

2. A liquid-crystal display apparatus according to claim 1, characterized in that said first terminal for conduction between substrates and said second terminal for conduction between substrates are located linearly toward an edge opposing the edge to which the terminals are adjacent.

3. A liquid-crystal display apparatus according to claim 1, characterized in that image data is supplied to said first electrode pattern, and a scanning signal is supplied to said second electrode pattern.

4. A liquid-crystal display apparatus comprising:

a first substrate having a first terminal for conduction between substrates, located adjacent to the edge of the substrate, and having a first electrode pattern which is electrically connected to said first ~~substrate~~terminal for conduction between substrates and which is arranged so as to extend toward an edge opposing the edge to which said first ~~substrate~~terminal for conduction between substrates is adjacent; and

a second substrate having ~~an~~ ~~input~~ terminal for input from the outside, located adjacent to the edge of the substrate, a second terminal for conduction between substrates, and a second electrode pattern, the substrates located in an opposed manner so as to extend in a direction in which said first electrode pattern and said second electrode pattern intersect with each other,

characterized by having a driving IC, mounted on said second substrate, an input terminal being electrically connected to said terminal for input from the outside, and an output terminal being electrically connected to said second terminal for conduction between substrates and said second electrode pattern, and

characterized in that said first terminal for conduction between substrates and said second terminal for conduction between substrates are electrically connected to each other by a conductive material sandwiched between said first substrate and said second substrate.

5. A liquid-crystal display apparatus according to claim 4,

characterized in that said first terminal for conduction between substrates and said second terminal for conduction between substrates are located linearly toward an edge opposing the edge in which those terminals are formed.

6. A liquid-crystal display apparatus according to claim 4, characterized in that image data is supplied to said first electrode pattern, and a scanning signal is supplied to said second electrode pattern.

ABSTRACT

In a liquid-crystal panel 1, for a second electrode pattern 50 extended around the ~~to~~ both sides on a second substrate 20 in such a manner as to avoid a first electrode pattern 40 formed on a first substrate 10, signal input is made directly from a second terminal 82 for input from the outside, and for the first electrode pattern 40 in which terminals 60 and 70 for conduction between substrates can be formed linearly, a signal is input by conduction between substrates. As a result, it is not necessary to perform conduction between substrates in a portion where a pattern must be extended obliquely, and for a portion where a pattern must be extended obliquely, only the second electrode pattern 50 capable of decreasing the distance between patterns may be formed.